Energy balance and body weight

INTAKE
Calories From Foods

OUTPUT
Calories Used During Physical Activity

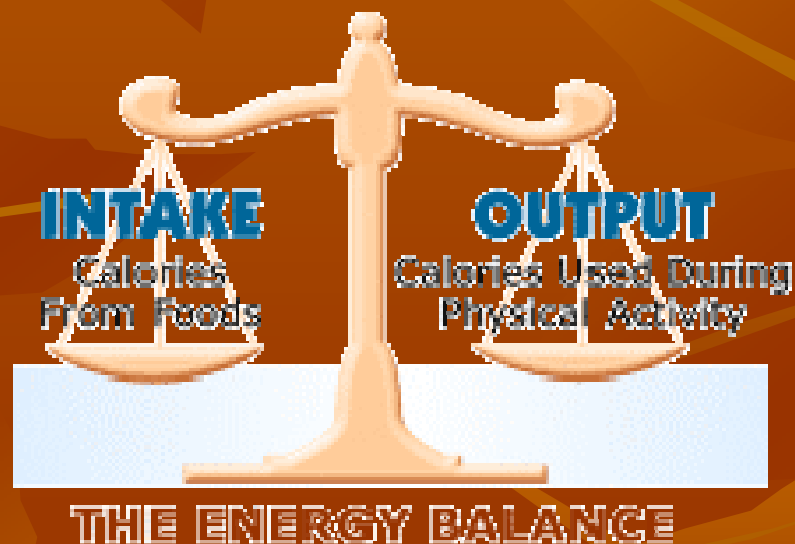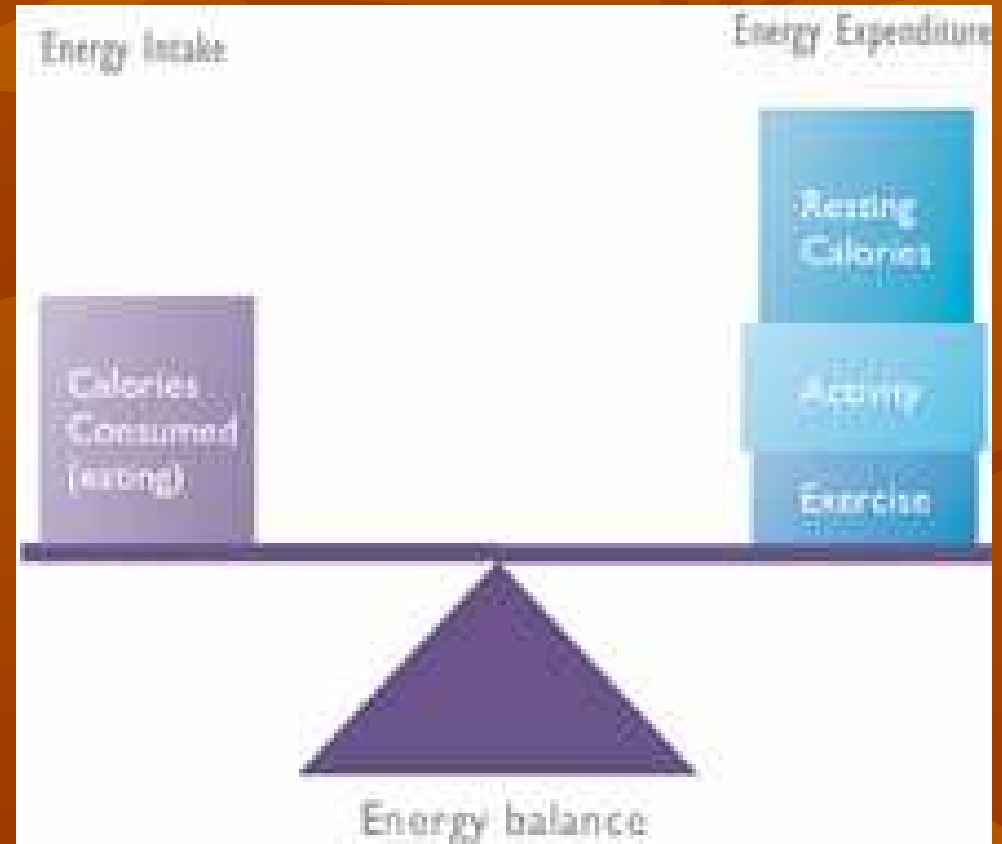THE ENERGY BALANCE

Energy balance

- People spend energy and eat periodically to refuel

- Ideally – energy intakes cover energy exptenditure

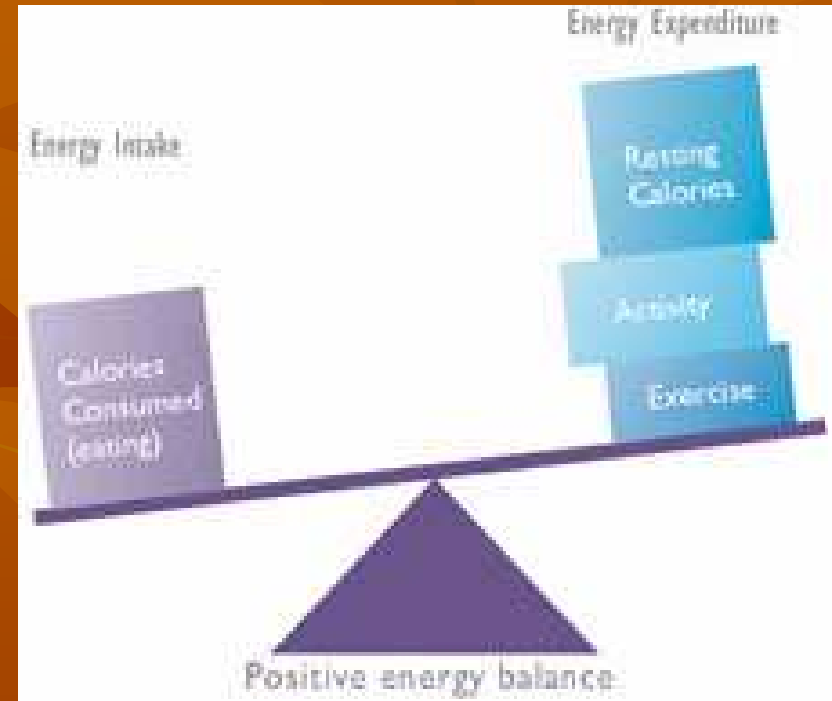 *(a person is mainteining body weight)*

Positive energy balance

- If more energy is taken in than is expended

=>

The person gains weight

- Excess energy => fat
  - 3500 kcal eaten in excess = 1 pound of body fat (454 g)
  - 1 pound of body fat – a mixture of fat, protein and water
    - 87 % body fat is fat (395 g x 9 kcal = 3500 kcal)
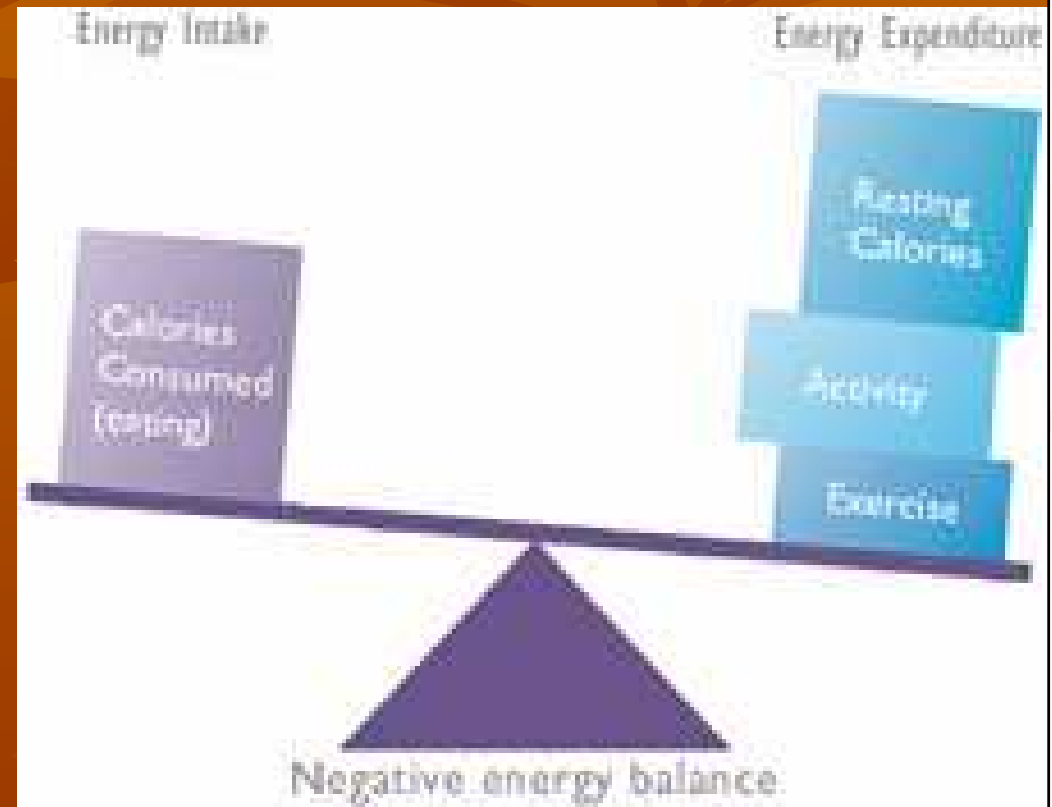
Negative energy balance

- If more energy is spent than is taken in

=>

The person loses weight

Energy in

- **The kcalories foods and beverages provide**
    - Kcalorie – a unit of heat energy
- Food energy value can be determined by:
    - Direct calorimetrie
        - measure the amount of heat released
    - Indirect calorimetrie
        - measure the amount of oxygen cosumed

- **The energy value of food**
    - 1 g Carbohydrates   4 kcal
    - 1 g Fat   9 kcal
    - 1 g Proteins   4 kcal
    - 1 g Alcohol   7 kcal

Energy out

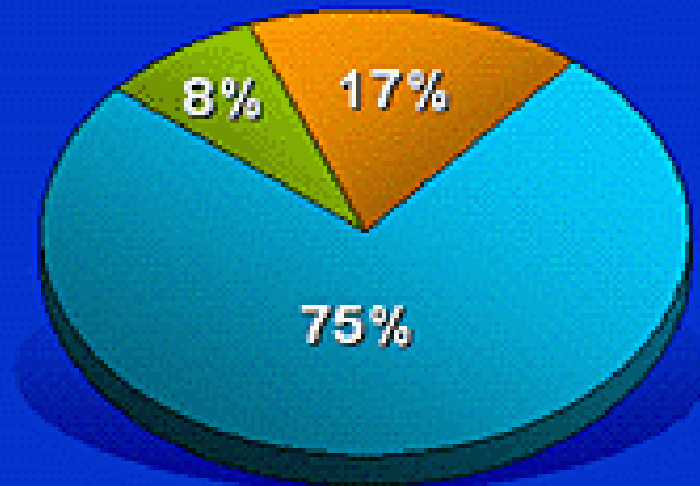- **The kcalories the body spends**

Components of Daily Energy Expenditure

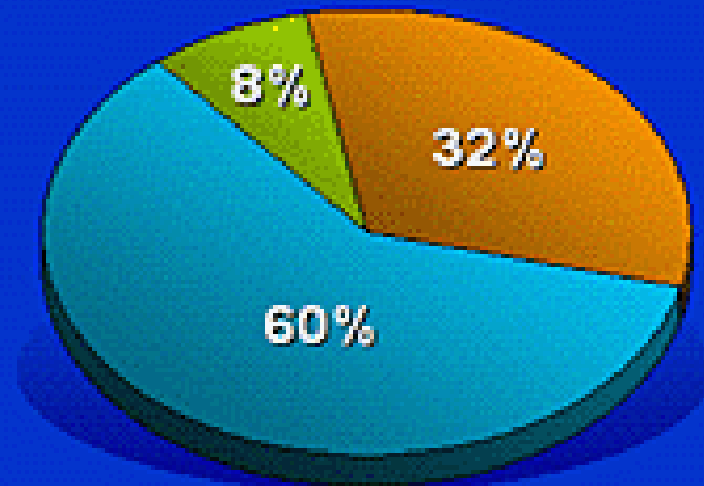- 🟩 Thermic effect of feeding
- 🟧 Energy expenditure of physical activity
- 🟦 Resting energy expenditure

Sedentary Person (1800 kcal/d): 8%, 17%, 75%

Physically Active Person (2200 kcal/d): 8%, 32%, 60%

Segal KR et al. *Am J Clin Nutr.* 1984;40:995-1000.

Source: Obesity Online Slide Library www.obesityonline.org

Components of energy expenditure

- **1. Basal metabolism (BM)**

  - 2/3 of energy
  - Energy neded to maintain life when a body is at complete digestive, physical, and emotional rest
  - Basal metabolic rate (BMR)
    - the rate of energy used for metabolism under specific conditions (after 12 hour fast and restful sleep, without any PA)
  - Resting metabolic rate (RMR)
    - Similar to BMR, but slightly higher
    - A measure of a person at rest in a comfortable setting, but with less stringent criteria for the number of hours fasting

Factors that affect the BMR
(Whitney, Rolfes, 2002)

Factor	Effect on BMR
Age	Lean body mass diminishes with age, slowing the BMR
Height	In tall, thin people, the BMR is higher
Growth	In children and pregnant women, the BMR is higher
Body composition	The more lean tissue, the higher the BMR. The more fat tissue, the lower the BMR
Fever	Fever raises the BMR
Stresses	Stresses (diseases, drugs) raise the BMR
Environmental temperature	Both heat and cold raises the BMR
Fasting/starvation	Both lowers the BMR
Malnutrition	Lowers the BMR
Hormones	The thyroid hormone thyroxin can speed up or slow down the BMR
Smoking	Nicotine increases energy expenditure
Caffeine	Caffeine increases energy expenditure
Sleep	BMR is lowest when sleeping

Components of energy expenditure

- 2. **Physical activity (PA)**

  - Voluntary movement of the sceletal muscle and support systém
  - The most variable component of EE
  - The amount of energy needed for PA depends on three factors:
    - Muscle mass
    - Body weight
    - Activity (duration, frequency, intensity)

Components of energy expenditure

- ## 3. Thermic effect of food (TEF)

  - An estimation of energy required to process food (digest, absorb, transport, metabolize, and store ingested nutrients)
  - Also called specific dynamic effect (SDE) or specific dynamic activity (SDA)
  - 10 % of EE
  - TEF is greater for high carbohydrate meal than for high fat meal

Estimating energy requirements

- In calculation are considered following componends

    - Energy spent on basal metabolism
    - Energy spent on physical activity
    - Energy spent on digesting and metabolizing food

Energy spent on basal metabolism

- **1. The Harris-Benedict Equation**

 Males: 66 + (13.7 x W) + (5 x H) - (6.8 x A)

 Females: 655 + (9.6 x W) + (1.7 x H) - (4.7 x A)

where W = actual weight in kg (weight in lb/2.2 lb/ kg)
        H = height in cm (height in inches x 2.54 cm/in)
        A = age in years

- **2. quick and easy estimate**

        Males: kg x 24 = kcal/day
        Females: kg x 23 = kcal/day

Energy spent on physical activity

Level of intensity	Type of activity	Activity factor (x BMR)	Energy expenditure (kcal/kg/day)
Very light	Seated and standing activities, painting trades, driving, laboratory work, typing, sewing, ironing, cooking, playing cards, playing a musical instrument	1,3 (men) 1,3 (women)	31 30
Light	Walking on a level surface at 2,5 to 3 mph, garage work, electrical trades, carpentery, restaurant trades, housecleaning, child care, golf, sailing, table tennis	1,6 (m) 1,5 (w)	38 35
Moderate	Walking 3,5 to 4 mph, weeding and hoeing, carrying a load, cycling, skiing, tennis, dancing	1,7 (m) 1,6 (w)	41 37
Heavy	Walking with a load uphill, tree felling, heavy manual digging, basketball, climbing, ootball, soccer	2,1 (m) 1,9 (w)	50 44
Exceptional	Training in professional or world-class athletic events	2,4 (m) 2,2 (w)	58 51

Energy spent on digesting and metabolizing food

10 % of BMR

A person who ingests 2000 kcalories in a day probably spends about 200 kcalories the TEF

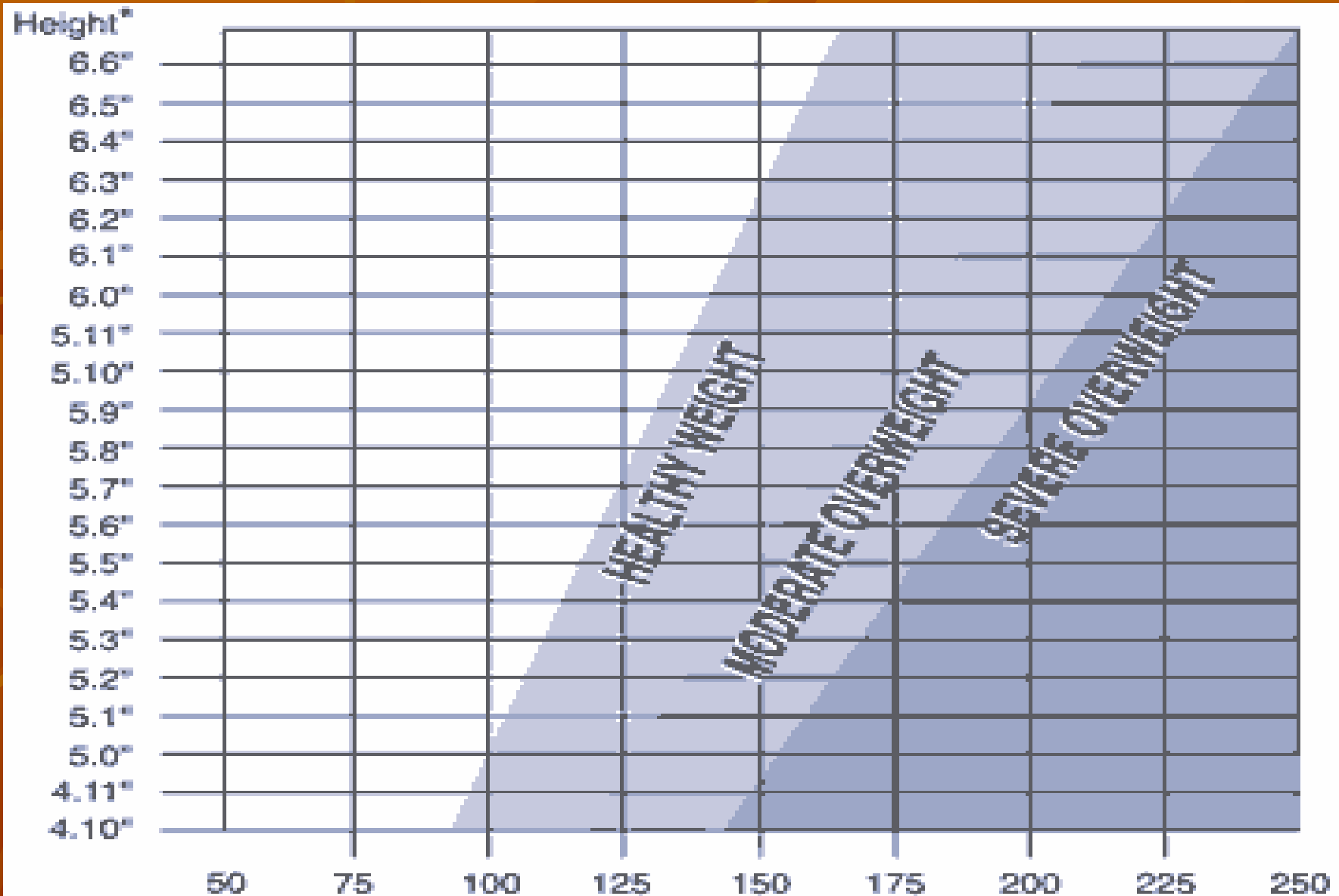# Body weight and body composition

- ## Body composition
  - The proportions of muscle, bone, fat, and other tissue that make up a person´stotal body weight

Body weight = fat + lean tissue
(including water)

Healthy body weight

- Is defined by the three criteria

  - A weight within the suggested range for height
  - A fat distribution pattern that is associated with a low risk of illness and premature death
  - A medical history that reflects an absence of risk factors asociated with obesity (elevated blood cholesterol, blood glucose, blood pressure)

Weight-for-Height Chart

Height*

6.6"
6.5"
6.4"
6.3"
6.2"
6.1"
6.0"
5.11"
5.10"
5.9"
5.8"
5.7"
5.6"
5.5"
5.4"
5.3"
5.2"
5.1"
5.0"
4.11"
4.10"

HEALTHY HEIGHT

MODERATE OVERWEIGHT

SEVERE OVERWEIGHT

50   75   100   125   150   175   200   225   250
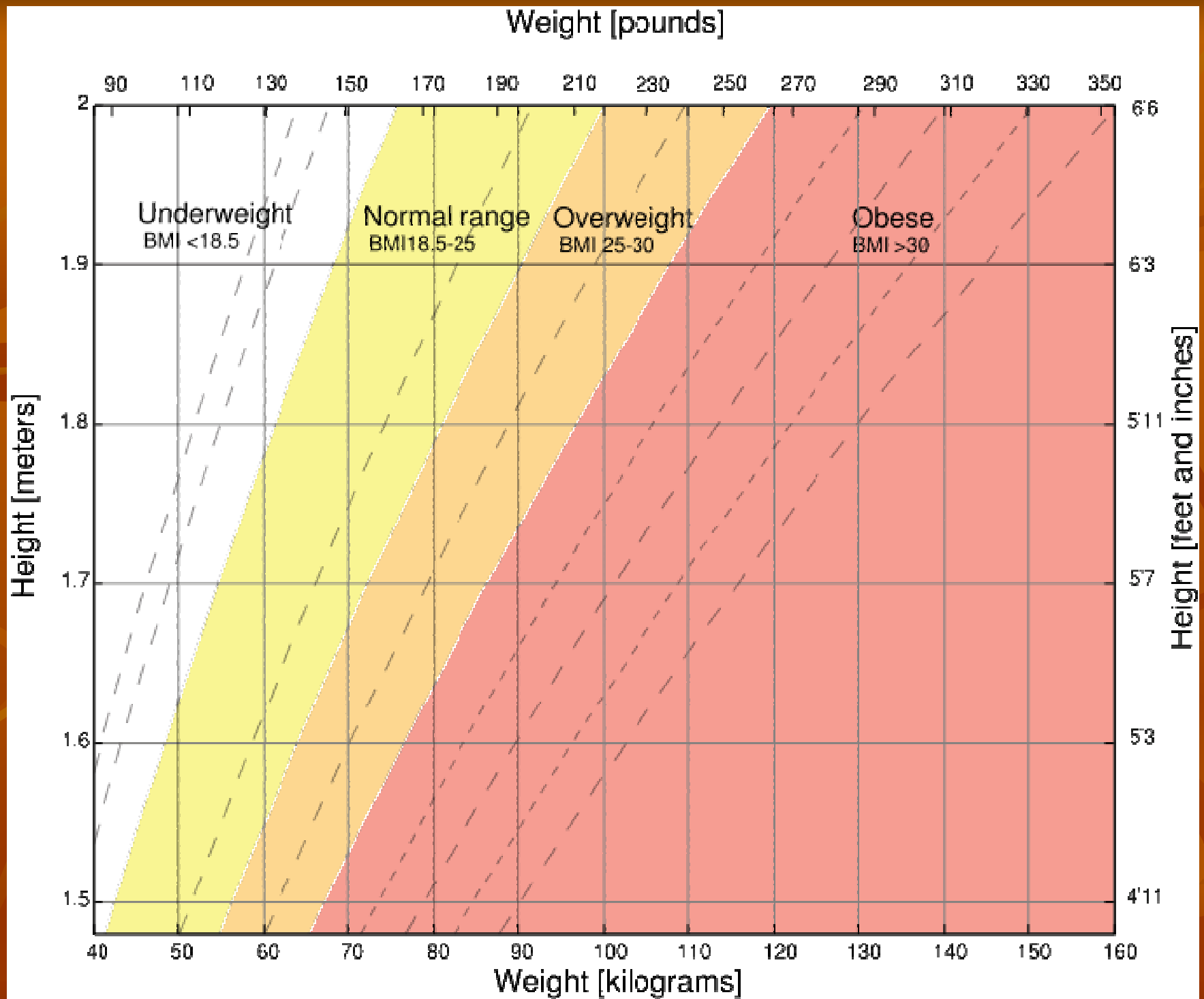
Pounds†

*   Without shoes

+   Without clothes.

     muscle and bone such as many men.

Body mass index

BMI is defined as the individual's <u>body weight</u> divided by the square of the height, and is almost always expressed in the unit kg / m2
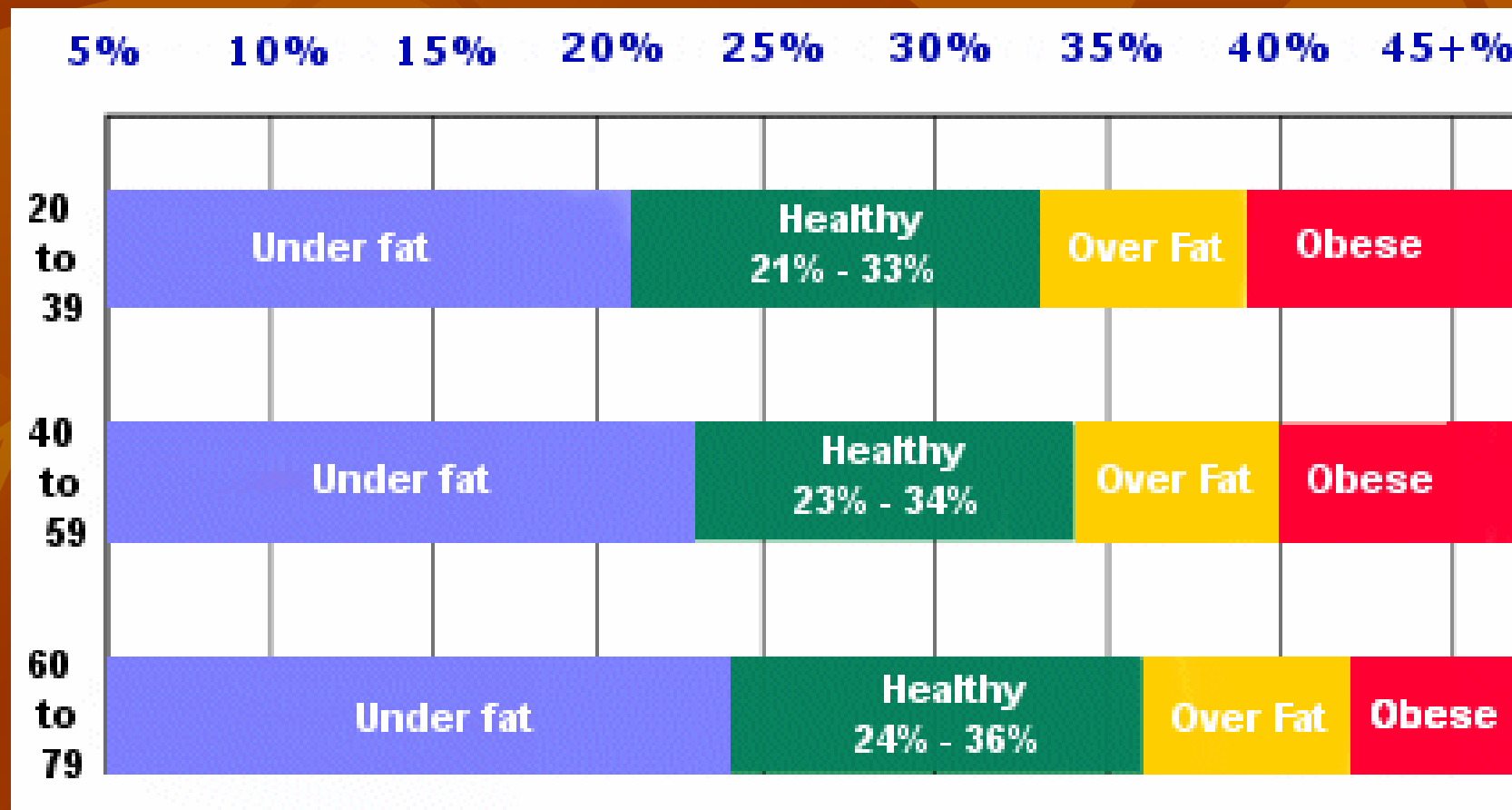
$$BMI = \frac{weight\ (kg)}{height \times height\ (m \times m)}$$

- Starvation: less than 15
- Underweight: less than 18.5
- Ideal: from 18.5 to 25
- Overweight: from 25 to 30
- Obese: from 30 to 40
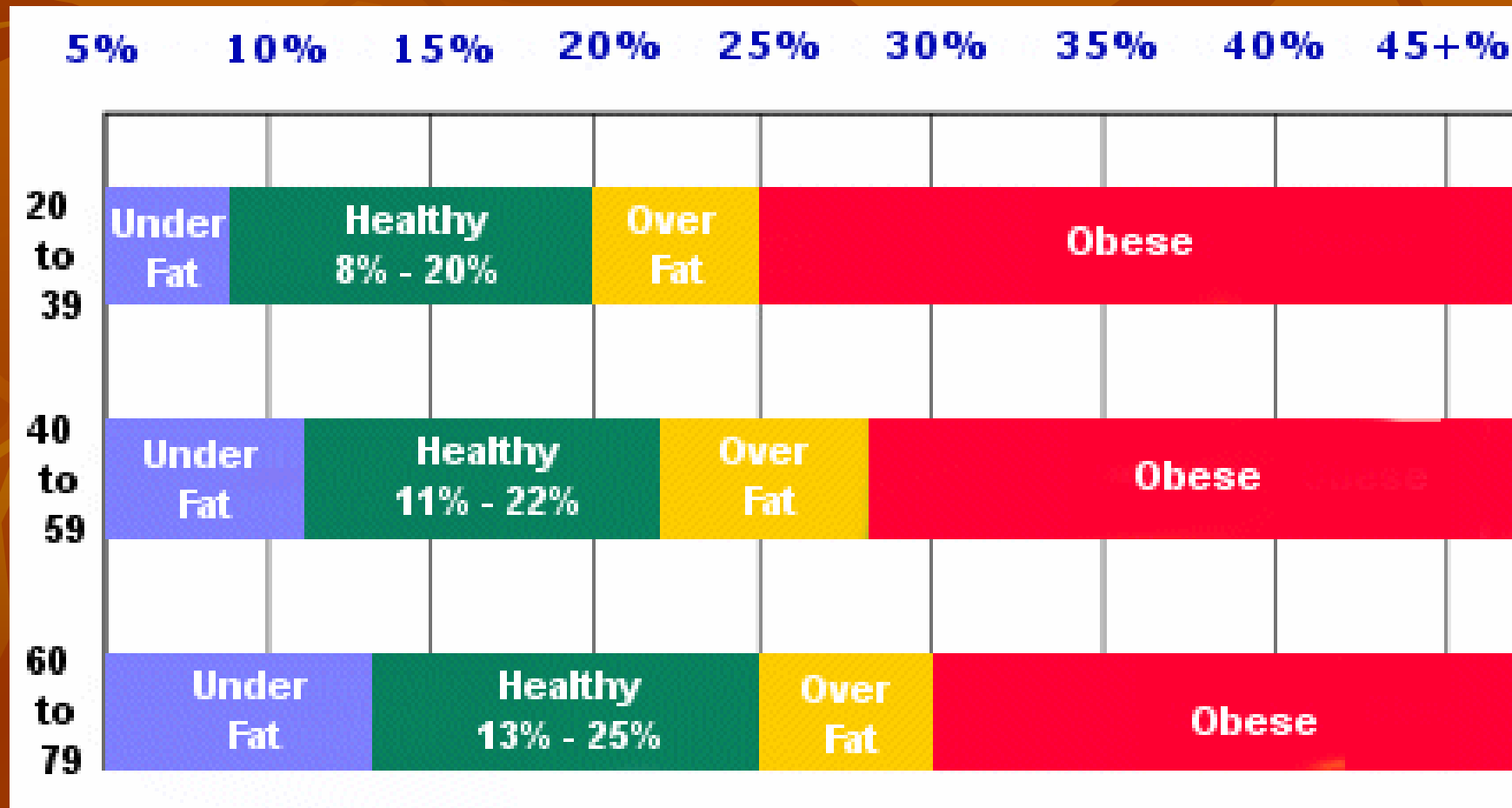- Morbidly Obese: greater than 40

Body fat and its distribution

Body Fat Guide - WOMEN

5%	10%	15%	20%	25%	30%	35%	40%	45+%
20 to 39	Under fat			Healthy 21% - 33%		Over Fat	Obese	
40 to 59	Under fat			Healthy 23% - 34%		Over Fat	Obese	
60 to 79	Under fat			Healthy 24% - 36%		Over Fat	Obese	

Body fat and its distribution

Body Fat Guide - MEN

Body fat and its distribution

- **Athletes – lower percentage**
  - 5 – 10 % for men
  - 15 – 20 % for women

- **Distribution**
  - Intra-abdominal fat – around the organs of the abdomen
    - Referred to as central obesity
    - Is associated with increase risk of heart disease, stroke, hypertension, diabetes, some types of cancer
    - More common in men
    - In women past menopause

Upper-body fat - apples (android obese)
Lower-body fat - pears (gynoid obese)

Theoretical contributors to body weight

Component	Lean man %	Lean women %
Water	62	59
Fat	16	22
Protein	16	14
Minerals	5 – 6	4 – 5
Carbohydrate	< 1	< 1

Body composition compartments

Component	Characteristics of component
Fat mass (FM)	Mass of body fat
% body fat (% BF)	% of total body mass that is fat mass
Fat-free mass (FFM)	Mass of body substances that are not fat, including water, protein, and minerals as found in organs, muscle, bone
Lean body mass (LBM)	Mass of FFM plus esential body fat
Total body water (TBW)	Toal of intracellular and extracellular water
Bone mineral mass (BMM)	Mass of mineral content of bone baased on estimators of bone density